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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Why models perform differently on particulate matter over East Asia? – A multi-model intercomparison study for MICS-Asia III" *by* Jiani Tan et al.

Anonymous Referee #3

Received and published: 21 November 2019

General Comments: The manuscript examines the spatial and temporal variability in aerosol concentration and composition simulated by 12 regional models. The model predictions are evaluated with measurements from the different monitoring networks. It also quantifies the ensemble mean bias through several processes, namely model inputs, gas to particle conversion, the impact of sea-salt and dust emissions parameterization, as well as deposition processes. The topic and overall approach fit with ACP. However, I feel that there are some aspects need to be discussed in more detail and the paper needs some improvement before being published in ACP.

As Reviewer #2 already mentioned, the supplementary material contains a very large

number of figures that could easily be added in the main text. In the current version, the readers have to go back and forth from the main text to the supplementary material.

It would be nice to have a more in-depth investigation of possible causes that could explain the substantial differences between simulations. As an example, there are large differences between simulations performed using the same model (see Figs.2, S9, S12 and S13). The M4 and M5 models seem to share similar setup and use the same input data, except the organic chemistry treatment. Then, how could the authors explain the different modelled spatial distribution of black carbon, SOR or C(NO2), as well as the different modelled concentrations of NO2 and NO3?

The logical connection between the manuscript and the SM needs to be improved. For example, the discussion associated with Fig. S8 appears after the one associated with Fig. S12.

Specific comments

Lines 104-105: it repeats information already provided in the introduction

Line 115: use "IC/BC" instead "BC"

Lines 164-165: Why the online calculation of natural emissions of dust and sea salt particles fully embedded within the WRF-Chem is not included?

Line 185: move this information into the main text

Lines 185-186: briefly describe the main findings of Chen et al., 2019

Lines 191-193: should be an NMB of -300%?

Lines 196-197: Fig. S3 instead of Fig. S2?

Lines 205-208: For northern and south-eastern EA these findings are not applicable. Could the authors explain why this behaviour is seen only for eastern EA, but not for the other analysed regions?

Lines 258-260: As Reviewer #1 already mentioned, using CO and BC concentration as proxies for emissions won't give a good indication of the emission's spatial distribution.

Lines 266-269: the models indeed do not provide the layer height in meters, but this can be easily calculated

Lines 273-276: these differences represent averaged values over the domain? It is difficult to connect these numbers with Fig S11. What do you mean by 2-6 ug m-3 for NO3? Do these numbers represent the range of differences? From Fig, S11 the range seems to be between -4 and 6 ug m-3.

Lines 277-279: have you compared these values with observations?

Lines 297-300: Why? A different aerosol treatment?

Figs. 2 and S13 and subsequent discussion: Could the authors provide an explanation for the really low NO3 concentration modelled with M8? Have they considered the M8 model when the ensemble mean was compared against observation? Using such outliers, the MMM mean can even be deteriorated compared to individual simulations.

Fig. 2 c) M3 should be M4

Lines 323-330: if the S emissions were insufficient, why the M13 and M14 models provide reasonable results?

Section 3.4: same as before, why not using the online calculation of natural emissions of dust particles within WRF-Chem?

Line 374: "perfectly" is a strong word

Lines 432-433: Table 4 and the associated discussion. Please be consistent when calculating the total wet and dry deposition of S/N and doing subsequent analysis.

Lines 460-473: In the case of wet deposition of S and N, M11 shows a very different spatial pattern compared with the other models. What is the reason for this? It would

be nice if the authors will try to analyse in detail the causes of these differences.

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